WATERSHED WORK PLAN

Lower Llagas Creek

Santa Clara County, California September 1967

TC
425
L52.W38
1967
c.2

WATERSHED WORK PLAN

LOWER LLAGAS CREEK WATERSHED

Santa Clara County, California

Prepared under the authority of the
Watershed Protection and Flood Prevention Act
(Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by

Loma Prieta Soil Conservation District
Santa Clara County Flood Control and Water District
South Santa Clara Valley Water Conservation District

With assistance by

Resources Agency of California, Department of Conservation,
Division of Soil Conservation
and
United States Department of Agriculture,
Soil Conservation Service

September 1967

TABLE OF CONTENTS

PAGE

SUMMARY OF PLAN 1

DESCRIPTION OF THE WATERSHED
- Physical Data 3
- Economic Data 5

WATERSHED PROBLEMS
- Floodwater Damage 7
- Sediment Damage 10
- Erosion Damage 10

PROJECTS OF OTHER AGENCIES 10

BASIS FOR PROJECT FORMULATION 11

WORKS OF IMPROVEMENT TO BE INSTALLED 13
- Land Treatment Measures 13
- Structural Measures 14

EXPLANATION OF INSTALLATION COSTS
- Land Treatment Measures 16
- Structural Measures 16

EFFECTS OF WORKS OF IMPROVEMENT 18

PROJECT BENEFITS 20

COMPARISON OF BENEFITS AND COSTS 21

PROJECT INSTALLATION 21

FINANCING PROJECT INSTALLATION 23

PROVISIONS FOR OPERATION AND MAINTENANCE 24

TABLES
- Table 1 - Estimated Project Installation Cost 26
- Table 1A - Status of Watershed Works of Improvement 27
- Table 2 - Estimated Cost Distribution 28

TABLE OF CONTENTS - (Continued)

PAGE

TABLES (Continued)

Table 3 - Structure Data - Grade Stabilization Structure 29
Table 3A- Structure Data - Channels 30
Table 4 - Annual Cost 31
Table 5 - Estimated Average Annual Flood Damage Reduction Benefits 32
Table 6 - Comparison of Benefits and Costs for Structural Measures 33

INVESTIGATIONS AND ANALYSES

Project Formulation 34
Land Treatment Measures 34
Structural Measures
Principles 35
Scope of the Project 36
Alternative Measures 36
Alternative Structure Locations 36
Alternative Types of Material 37
Alternative Levels of Protection 37

HYDROLOGIC INVESTIGATION

Watershed Hydrology 38
Hydrology for Economic Studies 39
Hydrology for Structural Design 40
Hydrologic Evaluation of Land Treatment Measures 40

GEOLOGIC INVESTIGATION

Sedimentation 40
Erosion 41
Channel Investigation 41
Materials 42

ECONOMIC INVESTIGATION

General 42
Land Use 43
Damage Evaluation
Types of Damages 44
Agricultural Damages 44
Urban Damages 45
Unevaluated Damages 46

TABLE OF CONTENTS - (Continued)

PAGE

ECONOMIC INVESTIGATION (Continued)
Benefit Evaluation

Benefits Attributed to Land Treatment Measures 46
Benefits Attributed to Structural Measures 46

SURVEYS 47

HYDRAULIC DESIGN 48

STRUCTURAL DESIGN 49

COST ESTIMATION

Land Treatment Measures 51

Structural Measures

Construction Costs 51
Installation Services 52
Rights-of-Way Costs 52
Utility Modification Costs 52
Administration of Contracts 53
Operation and Maintenance 53

PROJECT MAP Bound at end of Work Plan

WATERSHED WORK PLAN

LOWER LLAGAS CREEK WATERSHED
Santa Clara County, California

September 1967

SUMMARY OF PLAN

The portion of the Llagas Creek Watershed included in this work plan contains approximately 19,200 acres in south central Santa Clara County. It comprises the lower half of the Llagas Creek Watershed, the West Branch of Llagas Creek, and the Miller Slough drainage. The upper part of the Llagas Creek drainage is included in the Upper Llagas Creek Watershed Project for which a separate work plan is being prepared by the sponsors for concurrent submittal.

The works of improvement to be installed on the Lower Llagas Creek Watershed are inter-dependent with those to be installed on the upper watershed. The channel improvements on Lower Llagas Creek should be completed prior to construction of channel improvements included in the Upper Llagas Creek Project to obtain maximum benefits for both projects. The design capacities of the Lower Llagas Creek reflect the improvements proposed in the Upper Llagas Creek Watershed work plan.

Major flooding has inundated large areas within the watershed 12 times in the last 60 years. Historically, about one-third of the 19,200 acres in the Lower Llagas Creek Watershed has been inundated by a single flood, and nearly one-half of the area has been subjected to flooding at one time or another.

The sponsors propose to solve the flood problem through the application of both land treatment and structural measures. The land treatment program includes cover and green manure crops, crop residue use, pasture and hayland planting, irrigation water management, and farm ponds.

The structural measures consist of constructing or enlarging 17.2 miles of channels on Llagas Creek and its tributaries.

All structural measures except the lowermost 1.8 miles of Llagas Creek will be designed to contain a flood that will be equaled or exceeded once in a hundred years, that is, a 1-percent event. The extreme lower reach of Llagas Creek will have a capacity which varies from a 10-percent flow at the junction with the Pajaro River to the full 1-percent discharge at the edge of Soap Lake.

The total cost of installing land treatment and structural measures is $7,036,400 of which $4,655,000 or 66 percent will be from Public Law 566 funds. The remaining $2,380,700 together with $19,200 annual operation and maintenance cost, will be borne locally. It is anticipated that $375,900 will be expended the first year on all measures and $2,425,400, $2,149,800, $1,421,100 and $664,200 respectively during the subsequent years of a 5-year period.

The total average annual cost of the structural measures including amortized installation and operation and maintenance is $245,800. Comparing this with $438,800 of anticipated average annual benefits yields a benefit-cost ratio of 1.8 to 1.0.

This work plan is jointly sponsored by the Santa Clara County Flood Control and Water District, the South Santa Clara Valley Water Conservation District, and the Loma Prieta Soil Conservation District. The Flood Control and Water District will be the local agency responsible for project installation and operation and maintenance. Land treatment measures will be installed and maintained by individual farmers and ranchers cooperating with the Soil Conservation District.

The above agencies participated in the technical planning together with the Soil Conservation Service of the U.S. Department of Agriculture and the Division of Soil Conservation of the Department of Conservation, Resources Agency of California.

DESCRIPTION OF THE WATERSHED

PHYSICAL DATA

Santa Clara Valley extends from the southern tip of San Francisco Bay to Hollister about 50 miles to the southeast. The northern part of the valley drains into San Francisco Bay, and the southern part drains into the Pajaro River and thence westward into Monterey Bay through a gap in the Santa Cruz Mountains.

During periods of high runoff, Pajaro River water is backed up onto the South Santa Clara Valley floor to form Soap Lake. Llagas Creek flows into Soap Lake from the north, draining the valley floor area as well as a portion of the Santa Cruz Mountains to the west and a small foothill area to the east.

Of the 54,100 acres tributary to Llagas Creek where it enters Soap Lake, 19,200 are within the watershed area analyzed for this plan and the balance is in the Upper Llagas Creek Watershed. The confluence of Little Llagas Creek and Llagas Creek serves as the dividing point between the Upper and Lower Llagas Creek Watersheds (see Project Map).

Over 70 percent of the Lower Llagas Creek Watershed is within the valley floor. This area within the valley floor, which is roughly 10 miles long and averages about 2 miles wide, ranges in elevation from 140 to 300 feet above sea level.

Fruit and vegetable crops predominate in these highly productive agricultural lands. Some pasture and grain are grown around the fringes of the valley floor. About 9 percent of the valley land is presently devoted to urban use. In 20 years this percentage is expected to increase to about 30 percent. The remaining land is expected to remain in agriculture.

East of the valley floor, steep, lightly vegetated hills rise to 1,600 feet in elevation. Presently this area is in range and brushland.

Llagas Creek has its headwaters on the slopes of Mt. Chuai and flows through densely wooded hills for its first 7 miles. For the next 10 miles it flows through a narrow valley as it drains the hills on both sides through numerous small tributaries. Midway in this reach the South Santa Clara Valley Water Conservation District has constructed Chesbro Reservoir which has a capacity of 7,630 acre-feet and a surface area of 275 acres. Llagas Creek flows 11 miles along the floor of the Santa Clara Valley within an alluvial channel, and intercepts Little Llagas Creek and several smaller creeks from the east and Miller Slough from the west. Altogether it is about 30 miles from Mt. Chuai to the Pajaro River along the Llagas Creek channel. The lower 9 miles of Llagas Creek are in the Lower Llagas Creek Watershed.

The soils of Lower Llagas Creek Watershed can be divided into three types on the basis of origin: (1) residual soils, (2) those soils overlying older alluvium, and (3) the soils associated with the younger alluvium.

The residual soils found in the uplands have developed in place on, and are derived from, the older rocks of the watershed. These soils are shallow to moderate in depth and are underlain directly by bedrock, usually sandstone, shale, or serpentine. The soils overlying the serpentine are generally heavy textured, but medium texture predominates among the soils derived from the sedimentary rocks.

The soils formed on older alluvial deposits are deep although several of the soil series in the category contain a claypan. Medium texture predominates in those series which occur as terraces and high fan deposits along the margins of the Santa Clara Valley and its larger tributary stream valleys.

Soils of the center of the main valley have developed on the younger alluvium. Some of this material is still subject to overflow during floods so that many of the soils have essentially no soil profile development. In texture the soils range from medium to coarse grained. Prime agricultural land is closely associated with these soils.

Climate in the Lower Llagas Creek area is typical of the central California coastal valleys, with warm dry summers and cool wet winters. Mean annual precipitation, almost entirely in the form of rain, varies between 19 and 23 inches within the watershed. About 76 percent of the mean annual rainfall occurs between December 1 and March 31, and 92 percent between November 1 and April 30.

The mean annual temperature is 58° F., and the monthly variation is between 66° F. in July and 48° F. in January. Extreme temperatures in Gilroy have varied between a low of 20° F. and a high of 116° F. The average frost free period is 273 days.

ECONOMIC DATA

Historically, agriculture has been the major industry in the project area. Even with today's trend toward urbanization, the growing, processing, and marketing of farm products accounts for about 85 percent of the annual [illegible] income; and 20 years from now agriculture will remain the predominant land use, as it is expected to still occupy 70 percent of the valley floor.

The valley land north of Gilroy is predominantly devoted to prune orchards with smaller areas in strawberries, grains, and hay. South of Gilroy, such crops as sugar beets, beans, garlic, tomatoes, and lettuce are grown. Most of the lands described above are irrigated by pumped ground water.

The non-agricultural sector of the area's economy is divided between manufacturing and commerce. Metal products manufacturing is an important industry, with the largest factory making earth-moving equipment. Commerce relies on the trade generated by the local population and traffic on U.S. Highway 101. An important factor in this segment of the local economy is the growing number of people who live within the watershed, but commute to a place of employment in the San Jose metropolitan area.

Urban development is expected to continue at an accelerating pace even without flood prevention. According to the Santa Clara County Planning Department, the population of Gilroy is expected to increase from its present 8,000 to about 50,000 by the year 2000. Forecasts made by the U.S. Department of Commerce and the California Department of Water Resources look for even greater amounts of urban development. While it is impossible to predict specific locations, relative amounts of the different types of urban development have been forecasted by the County

Planning Department.

Land use within the watershed is tabulated below:

Land Use	Acres	Percent
Crop Land	9,570	50.0
Pasture and Hay	3,750	19.5
Range	4,740	24.6
Urban and Other	1,140	5.9
TOTAL	19,200	100.0

The urban development within the watershed is concentrated along and closely parallels the Southern Pacific Railroad and U.S. Highway 101 which run along the west side of the valley floor. Urban areas partially within the watershed include Gilroy and the unincorporated town of San Martin.

In addition to its highway and railroad connections, the watershed is traversed by State Highway 152 which connects Gilroy with the Monterey Bay area to the west and the San Joaquin Valley to the east. The watershed has an excellent network of all-weather roads serving both agricultural and urban areas.

The 1960 census indicated that approximately 10,000 people were living within the watershed. About 1,150 were residing on the 320 farm units. Most of these units are owner-operated.

Land values within agricultural areas range from $1,200 per acre for row crop land to $9,000 per acre for the best orchard areas. Average per acre values for the various types of land found within the watershed include $2,000 for range land, $3,000 for row crop land, and $4,500 for orchard land. Since farm income per acre ranges from $25 for irrigated pasture to $330 for prunes, it is evident that the pressure of urban expansion from the San Jose area is increasing land values far beyond their agricultural worth.

Urban land values range from a low of $2,500 per acre in the more isolated areas to a high of $9,000 near the City of Gilroy. Inside Gilroy some lands are valued at $3 per square foot.

Farms within the watershed range in size from 5 to 3,500 acres, with an average of 35 acres. Within the area subject to flooding, no farm units exceed 305 acres. There is no Federal land within the watershed.

WATERSHED PROBLEMS

FLOODWATER DAMAGE

Flood waters originating within the Llagas Creek Watershed inundate 6,700 acres within the Lower Llagas Creek Watershed once every 100 years on a long-term average with smaller acreages flooded at more frequent intervals.

Based on information provided by the Santa Clara County Assessor's office, the present value of land, improvements, and other property within the watershed is about $70,000,000 and conservative estimates indicate an increase to $345,000,000 by 1985. The flood hazard area includes more than 45 percent of the valley floor which is equivalent to roughly 35 percent of the lower watershed.

Agricultural damages associated with flooding include yield reductions and complete crop losses, forced delays in planting due to wet field conditions, the induction of additional weed growth and deposition of debris necessitating field clean-up operations, and induced plant diseases and rot. Urban damages consist of cleaning up, repairing or replacing those items within buildings and on their surrounding grounds that have come in direct contact with floodwaters.

Additional damages have been inflicted on other facilities such as roads and railroads, farm buildings and machinery, and irrigation systems. Interruption of communication and public utility services and the general disruption of the areal economy are tangible damages of lesser importance.

Such flooding occurs 4 years out of every 5, but the greatest part of the average annual damages is associated with flooding that occurs more frequently than 1 year out of every 5. Three out of every 4 major floods occur in the winter months of December, January and February and the remaining 1 comes in March or April.

Ten major floods have occurred since 1909, with the 2 most recent events occurring in 1955 and 1958. Since these latest floods are typical of the major floods within the watershed and reliable data has been collected on them, the flood damages associated with 1 of them will be described in detail.

After almost continuous heavy rainfall for a period of 1 week, a large flood peak was reached on Llagas Creek on December 23, 1955. Before the floodwaters receded, over 5,000 acres had been inundated within the Lower Llagas Creek Watershed, and severe loss was sustained due to flooding and prolonged inundation of garlic and lettuce fields. Homes, farm equipment, roads, and bridges were damaged in rural areas. In Gilroy, 16 city blocks were inundated along Miller Slough, and 225 people were forced to leave their homes for a 2-day period. Eighty-six people were provided shelter by the Red Cross.

Shallow flows of floodwaters, debris, and sediment in residential areas would cover lawns, flowers, and shrubs. There would be expensive clean-up, debris removal, replanting, and weed and disease control induced by floodborne weed seeds and disease.

Deeper floodwater and sediment would get into basements, damage foundations, sidewalks, driveways, fences, and other structures. With a maximum depth of 2 feet, water and sedimentwould get into newer homes, especially those with slab-floor construction. When water and sediment enters a house, rugs and upholstered furniture are seriously damaged, clothes, foodstuff, toys, electrical appliances, and other household effects would also be damaged or destroyed.

Homes in this watershed are increasing in value. There is a great increase in population in this area, and residential development is very active. While a conservative value of housing was used in the damage analysis, actual values are rising from a former range of $4,000 to $30,000 per house to a present range of $20,000 to $60,000 each, as old homes are replaced with modern subdivisions and luxury estate developments.

It has been estimated that a 100-year flood would presently cause about $250,500 damage in the residential area. Due to rapid developments of residential areas, damage in a 100-year flood, 20 years in the future, has been estimated to be $2,870,850.

In the commercial areas, shallower flood and sediment flows will be more damaging than in residential areas. Floor levels are generally lower and equipment and supplies more greatly damaged due to floor storage. Loss of business is a great item of damage.

The commercial areas are of the service type and much of it highway oriented, such as restaurants, motels, auto agencies, filling stations, launderies, grocery stores, drug stores, clothing stores, and other similar uses. With the rapid population growth and greater travel through the area, the commercial areas are expanding rapidly.

Values have been estimated to be over $246,600 per acre structural value including contents. A 100-year flood would presently cause about $41,400 damage while the same size flood 20 years hence would result in an estimated damage of $225,000 in the commercial areas.

Shallow flows of floodwater and sediment cause extensive damage in an industrial area since floors are usually at ground elevation, or lower. Equipment, motors, tools, pits, parts, hoists, and other appliances are damaged extensively by floodwater and sediment. Down-time of equipment results in loss of employment, loss of production, and excessive depreciation of buildings and equipment.

There is a little light industry in the area presently, which is mostly agricultural oriented. In the future, with expansion of the San Jose area industrial complex southward, it is expected that there will be a great expansion of industry along U.S. Highway 101 and the railroad, both of which are centered in the floodplain.

Values of industrial areas have been estimated to be $170,000 structure and contents per acre. It is this low due to inclusion of large yard storage areas and parking lots. A 100-year flood would presently cause approximately $240,000 of industrial damage, while the same size event 20 years in the future would cause an estimated damage of $1,175,000.

SEDIMENT DAMAGE

Damages ascribable to sedimentation are not easily separable from those due to floodwater. Damages to truck crops occur after the flooding due to a thin film of silt left by muddy overwash. The deposition of a relatively thin layer of debris on garlic fields occasionally prevents the emergence of the plants. Little of the damages sustained by orchard trees is directly attributable to sedimentation, although some clean-up is usually required. Streambed aggradation is not a problem in the watershed. Although some natural levees have been built by the streams, large-scale overbank deposition is not widespread.

Sediment damage to urban areas is of a similar type to that incurred by agricultural areas. Relatively thin deposits of silt are left by the retreating floodwaters on the floors of homes, in basements, and on lawns and gardens.

EROSION DAMAGE

Accelerated erosion and hence critical sediment source areas are not pronounced in the Lower Llagas Creek Watershed, however, several isolated instances of bank erosion and minor land loss were noted. Most of this erosion is due to bends in the stream or eddies caused by obstructions. Some of the channels in the watershed have well vegetated banks, but considerable bank damage caused by overbank flow occurred during the February 1963 storm.

PROJECTS OF OTHER AGENCIES

In order to alleviate a growing ground water shortage brought on primarily by heavy pumping for irrigation water, the South Santa Clara Valley Water Conservation District built 7,630 acre-foot Chesbro Reservoir on Llagas Creek in 1955. This structure is located in the Upper Llagas Creek Watershed. The reservoir functions by holding back runoff and then releasing water downstream slowly enough so that the entire amount can percolate into the ground. The primary percolation area on Llagas Creek is the 19,000 foot reach between U. S. Highway 101 and Masten Avenue.

In 1958 the District built 10,350 acre-foot Uvas Reservoir on nearby Uvas Creek and a 36-inch pipeline to import Uvas Creek water into the Llagas Creek Watershed to further supplement their supply of recharge water. Even though these two reservoirs have been highly successful in achieving the desired objective of supplementing ground water recharge, the sponsors have expressed no desire to develop additional agricultural water at this time because they have negotiated a contract to purchase imported water.

The Santa Clara County Flood Control and Water District has constructed a flood channel known as the Princevalle drain along the south city limits of Gilroy. Provision is made for this drain to empty into Miller Slough shortly above its confluence with Llagas Creek. This improvement will have no significant effect on flood damages within the area benefited by this work plan.

The U.S. Army Corps of Engineers has an active investigation on the Soap Lake and Pajaro River area downstream from the mouth of Llagas Creek.

Already constructed are flood control levees along the Pajaro River in the vicinity of Watsonville. Based on hydrologic studies, the inclusion of flood control storage within Chesbro Reservoir, as proposed in the Upper Llagas Creek work plan report, will offset any adverse effects channelization will have on downstream flood peaks. The Corps was consulted in preparation of this work plan.

BASIS FOR PROJECT FORMULATION

The objective of this study is to formulate a solution to the existing flooding problem and includes the related aspects of sedimentation and erosion. The area included in this watershed is a portion of the Llagas Creek drainage area within which this objective can be reached under Public Law 566.

Because urban expansion is imminent throughout nearly all of the project area and the California Soil Conservation Commission specifies a minimum level of protection for urban areas, all structural works of improvement, except the reach of Llagas Creek through Soap Lake, are designed to protect against a flood that will be equaled or exceeded once in a hundred years.

The Soap Lake area will be afforded the maximum protection attainable without any improvements on the

Pajaro River in order that the proposed measures will not adversely affect this lower Llagas Creek area. Soap Lake begins to form at the 10-percent flood event when the capacity of the Pajaro River is exceeded. It inundates the lower 9,200 feet reach of Llagas Creek at the 1-percent event.

Every effort was made to coordinate all structural works contemplated within this work plan with other existing or proposed projects within or near the project area in order to assure the full development of the soil and water resources. Special care was taken to assure coordination between this work plan and the flood detention structure and channel improvements proposed in the Upper Llagas Creek work plan.

The sizing and locating of structural measures were based on obtaining the maximum flood protection benefit for the entire Llagas Creek Watershed consistent with the chosen level of protection. In the cases of proportioning between flood detention storage and channel improvement, channel alignment, and investigating various diversion schemes, project formulation studies involved detailed cost studies to ascertain the relative merit of numerous alternative proposals.

The measures selected for achieving the project objective represent the optimum method for alleviating the flood problems. Providing flood detention storage as proposed in the Upper Llagas Creek work plan reduces peak flood flows by holding back runoff from the upper watershed. Channel improvement work increases the ability of the channels to contain these flows and to resist bank erosion. Land treatment measures are included where they are found to make a definite contribution to problem solution through the reduction of runoff, erosion, or sediment production.

The project, as formulated, thus represents the best means available for fulfilling the desires of the sponsoring local organizations based on the experience, investigations, and technical knowledge of the various Federal, state, and local agencies consulted in the preparation of this report.

WORKS OF IMPROVEMENT TO BE INSTALLED

Kinds and amounts of land treatment measures specified herein represent estimates of the need based upon land capabilities and land use.

Structural measures are prescribed on the basis of an investigation made in sufficient detail to establish locations and feasibility. After work plan approval, further studies will be made to supply the details that will be necessary in preparation of construction plans and specifications. These studies may dictate alterations within the current scope and in accordance with technical standards of the Soil Conservation Service and the desires of the sponsoring groups.

LAND TREATMENT MEASURES

A basic element in the selection of land treatment measures for this work plan was to include only those measures which would have a measurable effect in preventing floodwater or sediment or would in some way complement the effectiveness of the proposed structural measures.

Most of the proposed on-farm land treatment measures serve to enhance the vegetative cover. The cover in turn decreases runoff by increasing rainfall interception and decreases erosion by reducing the direct exposure of the soil to rainfall impact and running water. Measures in this category are those involving seeding, planting, fertilizing, and properly using crop and range areas.

Other land treatment measures involved improvements such as grassed waterways, stream bank protection, and grade stabilization structures, which directly reduce sediment production. Field ditches and diversions serve to reduce floodwater damages. On the valley floor, land treatment such as pasture proper use and irrigation water management serves to insure proper use of agricultural land so that the benefits calculated in this plan can be realized.

While many land treatment measures are presently being installed, the rate of installation will have to be accelerated to reach the required amounts by the time the installation of structural measures is completed. The estimated costs of the measures to be installed during the project period are found in Table 1.

Cooperative agreements between the Soil Conservation District and individual farmers will include the land treatment measures agreed upon for application and will be consummated prior to project completion. Planning and installation costs, including $6,000 of Public Law 566 funds for accelerated technical assistance and $114,900 of other funds, amounts to $120,900.

The entire watershed area is covered by a standard soil survey; therefore no additional funds need be expended in that regard.

STRUCTURAL MEASURES

The plan for structural measures within the watershed consists of constructing 17.2 miles of improved or realigned channels.

The locations of these measures are shown on the project map. Costs by channel reaches are in Table 2; and other pertinent data, dimensions, and capacities are in Tables 3 and 3A.

Channel improvement work on Llagas Creek will consist of improving and straightening 7.5 miles of existing channel essentially along the present alignment and constructing about 1.2 miles of new channel in the vicinity of the Pacheco Pass Highway. Of the total distance of 8.7 miles, 4.2 miles are in non-cohesive soils requiring riprap protection on the channel banks and the remaining 4.5 miles are in cohesive soil allowing earth channels with vegetated banks.

The proposed channel will range in capacities from 8,900 cfs at the junction of Little Llagas Creek to 16,100 cfs at the edge of Soap Lake. Capacity in the Soap Lake reach gradually decreases from the 16,100 cfs to 10,000 cfs at its junction with the Pajaro River. Bottom widths range from 99 to 150 feet and depths from 8 to 15 feet. Maximum velocity will reach 7.6 feet per second for the earth channel and 8.8 feet per second for the rock-riprapped channel. Six drop structures are included to stabilize the proposed channel grade and thus prevent extensive erosion on Llagas Creek.

These channel improvements on Llagas Creek will alleviate much of the present flood problem by providing a trunk channel with adequate capacity to drain the tributary area. Installation cost for channel improvement work on Llagas Creek will be $4,224,500.

An additional 8.5 miles of channel improvement work will be required to carry floodwaters originating in the Miller Slough - West Branch Llagas area to Llagas Creek. All these channels will be unlined with vegetated banks as they will be located entirely in cohesive soils. These channels will substantially follow existing water courses in their upper reaches.

However, the majority of West Branch Llagas flows will be diverted eastward to the proposed Highway 101 freeway, then southeast along the freeway route to Miller Slough, bypassing the city of Gilroy. This diversion, henceforth called the Ronan Diversion, will have a system of feeder channels to intercept flood flows from the north and west.

Proposed channel sections for this system will range in capacity from 200 to 5,200 cubic feet per second, in bottom width from 8 to 50 feet, in depth from 2.8 to 11.6 feet, and will have velocities reaching 6.9 feet per second. No improvement will be required on Miller Slough through Gilroy. However, Miller Slough below the entrance of the Ronan Diversion will generally be realigned to join Llagas Creek a little more than a mile upstream from the present junction. Three drop structures are provided in the channel system to reduce velocities to allowable limits for the soils.

These channel improvements will serve to alleviate the present flood problems in Gilroy by carrying floodwaters originating in this area to Llagas Creek. Installation cost will be $2,691,000.

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

Costs for land treatment found on Table 1 are based on the estimated quantity-unit cost approach and total $120,900. Of this total, $105,800 represents the cost of physically applying the required measures and will be met by the landowner on whose property the measure is required. Over the 5-year installation period, technical assistance furnished by the Soil Conservation District will total $15,100 with $6,000 from Public Law 566 funds for accelerating the application rate of needed land treatment measures.

Installation costs of the planned land treatment measures are estimated by year as follows:

LAND TREATMENT COSTS

Fiscal Year	P.L. 566 Funds (Dollars)	Other Funds (Dollars)	Total (Dollars)
1	600	11,500	12,100
2	1,100	20,600	21,700
3	2,200	41,200	43,400
4	1,600	31,200	32,800
5	500	10,400	10,900
TOTAL	6,000	114,900	120,900

STRUCTURAL MEASURES

The estimated cost of structural measures found on Table 2 is based on quantities calculated as part of the engineering design. The construction cost was determined by multiplying these quantities by unit cost averaged from bid prices within the area and adding a 15 percent contingency factor. This factor is considered adequate because of the detailed surveys, geologic exploration, and design work completed for quantity determination.

Engineering costs are estimated as 17 percent of the construction cost. Seventy percent is assumed to occur in the year preceding construction and 30 percent during the construction year. An additional $20,000 provided for the geologic exploration to evaluate potential riprap sites will be spent the first fiscal year together with the $15,000 provided for hydraulic model studies of drop structures.

Other Federal installation service costs equaling about 5.5 percent of the construction costs are included during the years of construction. The above costs total $4,649,700 and will be met from Public Law 566 funds.

The construction of a new channel from Llagas Creek station 129+00 to 191+00 is a more costly alternative than enlarging the existing channel along its present alignment. The sponsors have expressed a desire to follow the more costly alignment and will bear the non-project costs which total $126,200 (see Table 2).

Other installation costs include obtaining rights-of-way, relocating or rebuilding bridges, roads and other utilities, and local administrative cost.

Estimates of rights-of-way costs were obtained by Santa Clara County Flood Control and Water District. They are based on recent sales of similar properties in the area. The total cost of lands required for rights-of-way is estimated to be $1,139,800 including the cost of acquisition based on $1,000 per parcel.

The estimated cost of providing 14 county, 2 state, 3 private, and 1 single track railroad bridge is $1,007,600; of this amount, $48,000 of the railroad structure cost is assignable to P.L. 566 funds, and the remaining total of $959,600 is from other funds. The cost of relocating 6 gas lines, 2 sewer lines, 1 micro-wave cable, 2 steel pipe lines, 4 wells and pumps, 8 power poles, 1 barn, and 2 county roads is $128,600, all of which is to be from other funds. Total estimated cost of bridges and relocation work from other funds is $1,088,200 (see footnote 4, Table 2). These costs include 15 percent for engineering and other installation services.

The cost for administration of contracts was estimated on the basis of 1 percent of the construction cost. This item is estimated to cost $37,800.

Estimated expenditures for structural measures by years are as follows:

COST OF STRUCTURAL MEASURES BY CONSTRUCTION YEAR

Fiscal Year	P.L. 566 Funds (Dollars)	Other Funds (Dollars)	Total (Dollars)
1	167,400	196,400	363,800
2	1,359,800	1,043,900	2,403,700
3	1,395,000	711,400	2,106,400
4	1,084,600	303,700	1,388,300
5	642,900	10,400	653,300
TOTAL	4,649,700	2,265,800	6,915,500

EFFECTS OF WORKS OF IMPROVEMENT

The primary effect of the measures proposed within this work plan is to reduce flood damage that is estimated to average $455,300 annually. Under present conditions, some flooding occurs 4 years out of 5. With one exception, the proposed works of improvement will reduce future flooding to only those events exceeding the 1-percent chance of occurrence. In the Soap Lake area, future flooding will continue with flows exceeding the 10-percent discharge in Llagas Creek. However, the flood control storage in Chesbro Reservoir will offset any adverse effects channelization will have on downstream flood peaks.

There would be an area of approximately 8,600 acres in the area benefited. Within this area, the works of improvement would alleviate damages to row crops, hay and pasture, and orchards in the agricultural area and would prevent damages to homes, shops, stores, service facilities and industrial plants in urban areas.

The effect of the works of improvement would be to reduce the danger to public health caused by the presence of floodwaters. Included in this category are the contamination of wells, induced insect breeding, and the disruption of sanitation facilities.

Land treatment measures will be effective in reducing sediment production and floodwater runoff. In conjunction with the fire control program proposed in the Upper Llagas Creek Watershed work plan which will reduce the average annual burn rate in the upper watershed from 1.88 percent to 0.75 percent, sediment production will be reduced by about 10 percent.

In the floodplain area this will effect about a 2-percent reduction in sediment deposition. The decrease in runoff ranges from a 2-percent reduction in floodpeaks on the 1-percent storm up to roughly a 10-percent reduction in floodpeaks on annual storms. These reductions in sediment production and floodpeaks will, of course, have some beneficial effects in the area downstream from the Llagas Creek Watershed.

Special care was taken in the design of structural measures to prevent any detrimental effects in areas downstream from the proposed structural measures. The tendency of better channelization to increase floodpeaks downstream is offset by the reduction effected by providing flood detention storage as proposed in the Upper Llagas Creek work plan report.

A general increase in the level of economic activity will also develop as a result of the great reduction in the threat of flooding. Increased economic activity in any area raises local purchasing power. The effects from the local and national viewpoint were not considered in the evaluation.

The effects of damages to farm buildings and property, agricultural equipment, and such public facilities as roads and utilities were not evaluated.

This plan will have minor influence on wildlife resources. The reduction of small game that may result where channel improvements will destroy natural habitat will be mitigated by retaining plant growth on channel banks and levees whenever possible, and by planting wildlife food and cover along new banks and levees where feasible. Care will be used in channel maintenance to avoid use of materials toxic to fish and wildlife.

PROJECT BENEFITS

The total average annual evaluated damage caused by floodwaters within the watershed amounts to $455,300. This figure includes direct and indirect damages associated with floodwater and sediment in both agricultural and urban areas.

In the area where complete flood protection will be provided up to the 1-percent event, the benefits to be achieved by the structural measures are the same as the damage amount, less the benefits due to land treatment measures, which were evaluated as the first increment of damage reduction. Benefits were not claimed for the Soap Lake area which will not receive complete flood protection with this project.

The land treatment measures under the proposed accelerated program will reduce flood damage by about $52,900 annually. Benefits attributable to structural measures of $438,800 include primary benefits of $402,400 and secondary benefits of $36,400 (see Table 6).

Agricultural damage prevention due to structural works of improvement would be $23,300 annually due to floodwater damage and $4,100 annually due to sediment damage. Row crops would be benefited to the extent of $22,190, orchards $3,290, and hay and pastures would be benefited by $1,920 annually.

Urban damage prevention would be annual reduction of floodwater and sediment damages of $196,200 to residential areas, $22,100 to commercial, and $151,800 to industrial enterprises.

Evaluated indirect benefits include a reduction in service, interruptions of major communication and transportation facilities as well as such public utilities as gas, water, sewage, and power lines. Interruption of these facilities affects numerous users and, in the case of the highway and railroad lines between San Francisco and Los Angeles, would be extremely serious during a national emergency.

COMPARISON OF BENEFITS AND COSTS

Total evaluated average annual equivalent benefits to be achieved by the structural measures are $438,800. This total includes primary and secondary benefits of $402,400 and $36,400 respectively. The average annual equivalent cost of the measures to be installed in order to produce these benefits is $245,800. The ratio of benefits to cost is 1.8 to 1.0. The ratio without the inclusion of secondary benefits is 1.6 to 1.0.

PROJECT INSTALLATION

The land treatment measures will be installed by individual landowners with technical assistance provided by the Soil Conservation Service in cooperation with the Loma Prieta Soil Conservation District.

In order that the application of land treatment measures be completed during the five year installation period, accelerated technical assistance will be provided by the Soil Conservation Service. The Service will also continue the going program of technical assistance for developing proper conservation farm plans and designing land treatment measures during the installation period.

The installation of structural measures will be accomplished over a 5-year project period in accordance with the following schedule by fiscal years.

First Year

Geologic exploration to locate a suitable source for rock riprap and hydraulic model studies of drop structures.

Preparation of designs and specifications, and acquisition of rights-of-way for channel improvements on Llagas Creek from the lower limit of the project upstream to the proposed junction with Miller Slough.

Second Year

Construction of Llagas Creek channel improvements from the lower limit of the project upstream to the proposed junction with Miller Slough.

Preparation of designs and specifications, and acquisition of rights-of-way for channel improvement work on Miller Slough, the Ronan Diversion, and their tributary channels.

Third Year

Construction of channel improvement work on Miller Slough, the Ronan Diversion, and their tributary channels.

Preparation of designs and specifications, and acquisition of rights-of-way for channel improvements on Llagas Creek from the proposed junction with Miller Slough upstream to Buena Vista Avenue.

Fourth Year

Construction of Llagas Creek channel improvements from the proposed junction with Miller Slough upstream to Buena Vista Avenue.

Preparation of designs and specifications, and acquisition of rights-of-way for channel improvements on Llagas Creek upstream from Buena Vista Avenue.

Fifth Year

Construction of Llagas Creek channel improvement upstream from Buena Vista Avenue.

The construction is scheduled to protect the area presently subjected to the greatest damage at the earliest date possible without worsening downstream conditions. Hence channel work will begin with the improvement of the entire Llagas Creek reach below the proposed Miller Slough entrance.

The raising of Chesbro Dam as proposed in the Upper Llagas Creek work plan will be accomplished concurrently.

During the second construction year, the entire Miller Slough-West Branch Llagas Creek complex will be constructed to provide protection for the city of Gilroy. The remaining reach of Llagas Creek will be improved during the next two construction years with the uppermost reach being accomplished concurrently with the Llagas Creek channel improvement proposed in the Upper Llagas Creek work plan.

The Santa Clara County Flood Control and Water District will acquire or purchase all required rights-of-way, and make all necessary utility relocations and modifications for structural measures. The District will exercise its power of eminent domain if necessary. The District will also let and administer all construction contracts for the structural measures which will be constructed by a contractor selected by competitive bidding.

FINANCING PROJECT INSTALLATION

Land treatment measures to be installed during the project installation period will all be applied to private lands by the individual landowners. A portion of the installation costs of these features may be borne by current programs of the United States Department of Agriculture including the Agricultural Conservation Program. Loans may be obtained from the lending facilities of the United States Farmers Home Administration. Accelerated technical assistance will be provided within the financial framework of Public Law 566. The Service will continue to provide normal operating funds to maintain the going program of technical assistance.

The Soil Conservation Service will contribute from Public Law 566 funds the construction cost for the least costly alternative channel improvement. The Service will also bear the cost of the associated installation services consisting of preparation of contract plans and specifications, and the inspection of construction. The nonproject cost of $126,200 associated with the more costly alignment will come from non-Federal sources.

The Santa Clara County Flood Control and Water District will request funds from the State of California for reimbursement of the cost of rights-of-way and utility relocation under existing state law. The District has demonstrated the ability to obtain the necessary rights-of-way, and carry out utility relocations through experience gained on numerous channels it has constructed in the northern part of the county. The cost of administration of contracts will be borne by the Flood Control District.

The individual sponsoring organizations recognize their total financial obligation and the timing shown in the installation schedule. They are ready, as outlined above, to meet this obligation through local tax funds and state reimbursement.

These organizations are also aware that the financial and other assistance to be furnished by the U.S. Soil Conservation Service is contingent on the fulfillment of the local obligation presented in this plan and on congressional appropriation of the required funds. The sponsors do not contemplate obtaining funds from a loan under the provisions of the Act to finance project installation.

PROVISIONS FOR OPERATION AND MAINTENANCE

Operation and maintenance of on-farm land treatment measures will be the responsibility of the individual landowners on whose property the measure is installed. The Loma Prieta Soil Conservation District and the Soil Conservation Service will provide the technical advice and periodic inspections necessary to insure that the measures are being properly maintained.

All channel improvement work proposed in this plan will be operated and maintained by the Santa Clara County Flood Control and Water District at an estimated average annual expenditure of $19,200. The District is presently maintaining numerous flood channels elsewhere in the county by use of tax revenues, and is financially able to expand its program into the watershed.

The estimated cost includes allowances for the materials, labor, equipment, and overhead associated with such channel maintenance work as weed and brush control, rodent control, after flood clean-up, and structural repair to riprap and concrete structures. Maintenance roadways are provided along all improved channels.

Inspection of the works of improvement will be conducted in accordance with provisions of the Operations and Maintenance Agreement executed for the works of improvement.

Specific maintenance agreements will be executed prior to the issuance of invitation to bid for any construction contract. The Santa Clara County Flood Control and Water District is fully aware of all its responsibilities in this regard.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Lower Llagas Creek Watershed, California

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/ Public Law 566	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acres	5,370		85,900	85,900
Pasture & Hayland	Acres	550		12,300	12,300
Range land	Acres	1,440		5,900	5,900
Miscellaneous				1,700	1,700
Technical assistance	Dollars		6,000	9,100	15,100
TOTAL LAND TREATMENT			6,000	114,900	120,900
STRUCTURAL MEASURES					
Construction					
Channel Improvement	Miles	17.2	3,766,700		3,766,700
Installation Services					
Engineering Services			675,300		675,300
Other			207,700		207,700
Subtotal - Installation Services			883,000		883,000
Other Costs					
Land, Easements and R/W				2,228,000	2,228,000
Administration of Contracts				37,800	37,800
Subtotal - Other				2,265,800	2,265,800
TOTAL STRUCTURAL MEASURES			4,649,700	2,265,800	6,915,500
TOTAL PROJECT			4,655,700	2,380,700	7,036,400

1/ Price Base 1965

September 1967

TABLE 1A- STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of work plan preparation)

Lower Llagas Creek Watershed, California

Measure	Unit	Applied to Date No.	Applied to Date Dollars 1/
(1)	(2)	(3)	(4)
LAND TREATMENT			
Conservation Cropping System	Acre	320	300
Cover and Green Manure Crop	Acre	1,400	28,000
Crop Residue Use	Acre	1,800	2,700
Irrigation Water Management	Acre	2,000	10,000
Drainage Main or Lateral	Feet	30,000	6,000
Pasture and Hayland Planting	Acre	3,000	60,000
Pasture Proper Use	Acre	3,000	4,500
Range Proper Use	Acre	3,000	3,000
Farm Pond	No.	25	25,000
Range Seeding	Acre	100	1,000
Grade Stabilization Structure	No.	3	1,500
Grassed Waterway or Outlet	Acre	2	200
Sub-total			142,200
STRUCTURAL MEASURES			
Channel Improvement			363,000
Grand Total			505,200

September 1967

1/ Price base 1965

TABLE 2 - ESTIMATED COST DISTRIBUTION

Lower Llagas Creek Watershed, California
(Dollars) 1/

		INSTALLATION COST - PUBLIC LAW 566 FUNDS				INSTALLATION COST - OTHER FUNDS				
		Installation Services					Other			
Structure Identification	Channel Reach	Construction	Engineering	Other	Total P.L. 566	Construction	Adm. of Contracts	Easements & R/W 4/	Total Other	Total Installation Cost
LLAGAS CREEK										
Channel Improvement										
0+00 to 129+00	L1	511,500	121,900	29,100	662,500		5,100	302,500	307,600	970,100
129+00 to 191+00 2/	L1	592,000	100,600	32,500	725,100		5,900	222,500	228,400	953,500
129+00 to 191+00 3/	L1					(48,200)	(500)	(77,500)	(78,000)	(126,200)
191+00 to 357+50	L1,L2	918,500	156,200	50,400	1,125,100		9,200	353,400	362,600	1,487,700
357+50 to 458+00	L2	581,900	98,900	31,900	712,700		5,800	94,700	100,500	813,200
Subtotals		2,603,900	477,600	143,900	3,225,400		26,000	973,100	999,100	4,224,500
MILLER SLOUGH										
Channel Improvement										
"A" Line										
0+00 to 55+00	R1	212,300	36,100	11,600	260,000		2,100	101,400	103,500	363,500
55+00 to 182+00	R1	419,500	71,300	23,000	513,800		4,200	591,600	595,800	1,109,600
182+00 to 211+00	R1	55,000	9,400	3,000	67,400		600	117,100	117,700	185,100
211+00 to 250+00	R1	96,500	16,400	5,300	118,200		1,000	47,800	48,800	167,000
250+00 to 285+00	R1	48,600	8,300	2,700	59,600		500	61,100	61,600	121,200
"B" Line (West Br. Llagas)										
226+00 to 297+00	R2	157,000	26,700	8,600	192,300		1,600	97,400	99,000	291,300
182+00 to 226+00	R2	110,200	18,700	6,100	135,000		1,100	139,000	140,100	275,100
"C" Line (North Channel)										
211+00 to 217+00	R2	8,400	1,400	500	10,300		100	10,800	10,900	21,200
217+00 to 233+00	R2	25,000	4,300	1,300	30,600		300	39,600	39,900	70,500
"D" Line (South Channel)										
217+00 to 245+00	R2	30,300	5,100	1,700	37,100		300	49,100	49,400	86,500
Subtotals		1,162,800	197,700	63,800	1,424,300		11,800	1,254,900	1,266,700	2,691,000
GRAND TOTALS		3,766,700	675,300	207,700	4,649,700		37,800	2,228,000	2,265,800	6,915,500

1/ Price Base 1965.
2/ Alignment following existing channel (least costly alternative).
3/ Alignment that the sponsors indicate they will follow. Amounts shown in parentheses are nonproject costs that will be borne by the sponsors and are not included in totals. (Sponsors will contribute 7.53% of the construction cost).
4/ Includes costs for utility relocation and bridges ($1,088,200).

September 1967

TABLE 3 - STRUCTURE DATA

GRADE STABILIZATION STRUCTURE

Lower Llagas Creek Watershed, California

Location (Station)	Type of Structure	Drop (feet)	Spillway width (feet)	Depth of water up-stream (feet)	Concrete (c.y.)
Llagas Creek					
129 + 00	Modified trapezoidal	6.1	92	13.9	358
150 + 00	Mod. trap.	8.6	84	15.0	470
191 + 00	Mod. trap.	10.4	78	10.6	432
298 + 90	Mod. trap.	4.0	79	10.5	230
386 + 00	Mod. trap.	4.0	67	12.0	264
420 + 00	Mod. trap.	6.1	74	11.0	302
Miller Slough, Ronan Diversion & West Branch Llagas Creek					
"A" 55 + 00	Type C	8.1	63	9.8	281
"A" 56 + 00	1/	4.0	--	4.0 2/	30
"B" 184 + 00	Type C	5.6	54	7.2	171
"B" 252 + 00	Type C	6.4	78	7.2	231

1/ Trapezoidal concrete chute confluence structure in Old Miller Slough at entrance into new channel.

2/ Depth in Old Miller Slough

September1967

TABLE 3A - STRUCTURE DATA

CHANNELS
Lower Llagas Creek Watershed, California

Channel Designation Station to Station	Channel Reach	Watershed Area 1/ (sq. miles)	Design Channel Capacity (cfs.)	Bottom Width (ft.)	Depth of Water 5/ (ft.)	Channel Gradient (ft./ft.)	Design Velocity (ft./sec.)
LLAGAS CREEK							
0+00 to 30+00	L-1	99.5	10,000 2/	150	9.3	.0010	6.4
30+00 to 47+50	L-1	99.5	14,300 3/	150	11.5	.0010	7.2
47+50 to 93+40	L-1	84.4	13,900 4/	120	12.8	.0010	7.5
93+40 to 121+00	L-1	84.4	16,100	120	13.9	.0010	7.9
121+00 to 129+00	L-1	84.4	16,100	120	13.9	.0010	7.9
129+00 to 150+00	L-1	84.4	16,100	120	13.9	.0010	7.9
150+00 to 191+00	L-1	84.4	16,100	130	15.0	.0009	6.7
191+00 to 298+90	L-1,L-2	61.7	9,300	100	10.6	.0016	7.2
298+90 to 357+50	L-2	61.7	9,300	100	10.5	.0012	7.3
357+50 to 386+00	L-2	61.7	9,300	100	10.5	.0012	7.3
386+00 to 420+00	L-2	58.9	8,900	99	12.0	.0010	6.0
420+00 to 441+00	L-2	58.9	8,900	122	11.0	.0009	5.6
441+00 to 458+00	L-2	58.9	8,900	111	8.0	.0031	8.8
MILLER SLOUGH							
"A" Line							
0+00 to 55+00	R-1	18.3	5,200	50	11.6	.0009	6.1
55+00 to 182+00	R-1	13.3	4,200	46	9.8	.0013	6.6
182+00 to 211+00	R-1	4.6	2,000	24	8.0	.0017	6.3
211+00 to 250+00	R-1	2.4	1,150	35	4.1	.0035	6.6
250+00 to 285+00	R-1	1.9	800	23	4.1	.0035	6.3
"B" Line							
182+00 to 226+00	R-2	6.6	2,900	44	7.2	.0020	6.9
226+00 to 297+00	R-2	6.1	2,700	40	7.2	.0020	6.8
"C" Line							
211+00 to 217+00	R-2	1.9	900	8	7.2	.0020	5.6
217+00 to 233+00	R-2	1.3	630	8	5.6	.0030	5.8
"D" Line							
217+00 to 230+00	R-2	0.6	200	8	3.5	.0020	3.8
230+00 to 245+00	R-2	0.6	200	8	2.8	.0052	5.4

1/ Areas tributary to Llagas Creek includes the area of the Upper Llagas Creek Watershed
2/ 10 percent discharge
3/ 4 percent discharge
4/ 2 percent discharge
5/ Depth associated with design flows

September 1967

TABLE 4 - ANNUAL COST

Lower Llagas Creek Watershed, California

(Dollars) 1/

	Amortization 2/ of Installation Cost	Operation and Maintenance 3/ Cost	Total
Channel Improvement	226,600	19,200	245,800

1/ Price Base 1965.

2/ Amortized over a 100-year period at 3-1/8 percent interest.

3/ Computed at long term projected price level.

September 1967

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Lower Llagas Creek Watershed, California

(Dollars) 1/

Item	Estimated Average Annual Damage Without Project	 With Project	Damage Reduction Benefits
Floodwater			
Agricultural			
Row Crops	18,870	0	18,870
Orchards	2,800	0	2,800
Barley & Vetch Hay & Pasture	1,630	0	1,630
Subtotal	23,300	0	23,300
Nonagricultural			
Residential	166,500	0	166,500
Industrial	128,800	0	128,800
Commercial	18,800	0	18,800
Subtotal	314,100	0	314,100
Subtotal Floodwater Damage	337,400	0	337,400
Sediment			
Agricultural			
Row Crops	3,320	0	3,320
Orchards	490	0	490
Barley & Vetch Hay & Pasture	290	0	290
Subtotal	4,100	0	4,100
Nonagricultural			
Residential	29,700	0	29,700
Industrial	23,000	0	23,000
Commercial	3,300	0	3,300
Subtotal	56,000	0	56,000
Subtotal Sediment Damage	60,100	0	60,100
TOTAL DIRECT	397,500	0	397,500
Indirect	57,800	0	57,800
TOTAL FLOOD PREVENTION BENEFITS 2/	455,300	0	455,300
BENEFITS WITHIN THIS WATERSHED BUT ATTRIBUTED TO WORKS OF IMPROVEMENT IN THE UPPER LLAGAS CREEK WATERSHED 3/	73,200	0	73,200
GRAND TOTAL	528,500	0	528,500

1/ Price Base long-term projected level.

2/ Damages from floods larger than the 100-year flood will occur but were not evaluated.

3/ Includes Agricultural and Nonagricultural floodwater and sediment damage as well as indirect damage.

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Lower Llagas Creek Watershed, California

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS Flood Prevention Damage Reduction 2/	AVERAGE ANNUAL BENEFITS Flood Prevention Secondary	AVERAGE ANNUAL BENEFITS Total	Average Annual Cost 3/	Benefit Cost Ratio
Lower Llagas Creek	402,400	36,400	438,800	245,800	1.8:1.0

1/ Price base: Benefits on long term and costs in 1965.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $52,900 annually.

3/ O & M costs are computed at long term projected price level.

September 1967

INVESTIGATIONS AND ANALYSES

PROJECT FORMULATION

This watershed work plan incorporates the practical experience of many people who live within the watershed. The intimate knowledge of the flood problem of the Loma Prieta Soil Conservation District, the water management experiences of the South Santa Clara Valley Water Conservation District, and the technical help of the Santa Clara County Flood Control and Water District have all greatly facilitated formulation of the work plan.

The technical knowledge of the California Division of Soil Conservation, the U.S. Soil Conservation Service, the U.S. Army Corps of Engineers, the California Department of Water Resources and other Federal, state, and local organizations have been utilized in formulating a plan to establish a program of land treatment practices and structural measures that will maintain and protect the watershed from flooding.

The many points of view of the local people were given full consideration in deriving this plan, and as many of their suggestions as could be included within the framework and limitations of Public Law 566 are found herein. The sponsors and other interested local agencies were kept fully informed of the findings in each stage of project development by the Division of Soil Conservation and they were consulted each time a choice among alternative schemes was to be made.

LAND TREATMENT MEASURES

The land treatment measures were developed by technicians of the Soil Conservation Service and are based on the technical standards that they have developed from years of experience. The basic data consisted of a detailed tabulation of land within the watershed giving land classes, uses, and capabilities. From the tabulation, an inventory was made of the conservation needs of the watershed area and the corresponding land treatment measures required to fill these needs.

Also inventoried were the land treatment measures that have been previously installed (see Table 1A). The list of needed measures was then reduced so as to include only those that would have a measurable physical effect in preventing floodwater, erosion, or sediment damages or would be necessary to achieve the full benefit of the planned structural measures.

The total conservation need quantities were next reduced by the amount of measures presently installed and then further reduced to reflect the amounts of practices that could reasonably be accomplished during the project installation period with the optimum technical staff. A breakdown of land treatment by major land uses is found on Table 1. The accelerated program requires more technical assistance than the present staff can provide during the installation period. Costs for the additional staff will be met from Public Law 566 funds.

The present level of fire protection was analyzed and found to be adequate for the watershed.

STRUCTURAL MEASURES

Principles

The basic objective of the structural works of improvement included in this work plan is to provide the maximum flood protection to the watershed without regard to the relative Federal and non-Federal costs, and to fulfill, insofar as sound economic and engineering practice will allow, the desires of the sponsoring groups.

During project formulation, consideration was given to numerous alternative measures, types of materials, and levels of protection. Care was also exercised to insure that nothing is proposed for the present which would preclude a more comprehensive future development within the entire Llagas Creek Watershed. Special caution was also exercised to make sure the project will have no adverse effects on the downstream areas.

Scope of the Project

The measures presented in this work plan are interdependent with those proposed in the Upper Llagas Creek work plan. Consequently, the flood problems of the upper watershed were investigated in conjunction with this project. The solution to the flood problem presented herein represents the best solution considering the entire Llagas Creek Watershed.

Alternative Measures

A detailed inspection of the Lower Llagas Creek Watershed revealed no feasible reservoir site either on Llagas Creek or its tributary streams. However, suitable detention sites do exist in the Upper Llagas Creek Watershed. Increasing the capacity of existing Chesbro Reservoir by 3,500 acre-feet for flood storage is proposed in the Upper Llagas Creek work plan.

This was determined to be the optimum storage by estimating the combined cost of providing flood detention and downstream channel improvements for flood storage up to 5,580 acre-feet. The cost of channel improvement in both the upper and lower watersheds were considered in this optimization study.

Alternative Structure Locations

Numerous different channel locations were analyzed before the final plan was adopted. The proposed alignment for the main Llagas channel essentially follows the existing course except for the 6,200-foot reach starting at the proposed junction of Miller Slough and Llagas Creek which diverts southwesterly into Miller Slough and thence to the existing Llagas Creek alignment.

A comparison between the cost of constructing this diversion channel and the cost of improving the existing channel through a comparable reach showed the diversion channel to be more expensive. The sponsors chose the diversion plan and will bear the added construction and installation services costs involved. They are fully aware of the added financial obligation in choosing this more expensive alternative.

In addition to the plan selected, two alternative plans were considered in seeking a solution to the flood problems on the Miller Slough - West Branch of Llagas complex. They are: 1) improving the existing system of channels, and 2) the Day Road diversion plan.

Improving the existing system of channels proved too costly, particularly through the city of Gilroy, due to the high value of rights-of-way. To reduce the design flows and magnitude of channel improvements through the city of Gilroy, the Day Road diversion plan was formulated. Under the Day Road plan, the West Branch of Llagas Creek would be diverted starting at Day Road, and then running easterly into the Llagas Creek channel. Improvements would be required on Miller Slough for runoff that originates below the diversion.

Alternative Types of Material

On Llagas Creek a balance was achieved between the number and size of drop structures and channel excavation and lining cost. For those reaches requiring lining, ungrouted riprap was used in preference to other materials in order to keep interference with percolation to a minimum as well as for cost reasons. Lining was also found to be less costly than enlarging the channel and installing additional drop structures to reduce velocities.

Alternative Levels of Protection

The benefits and costs for various levels of protection were evaluated for the entire Llagas Creek Watershed in order to determine the optimum project. The additional benefits and costs associated with each increase in the level of protection were determined and then both plotted against frequency. The optimum level of protection (defined as the maximum level at which incremental costs equal incremental benefits) was thus found to be 1.5 percent.

However, in order to satisfy the criterion on minimum level of protection for urban areas of the California Soil Conservation Commission, all structural measures located where urban development is possible within the next 20 years were designed to contain a 1 percent flood.

The reach of Llagas Creek through the Soap Lake area which is expected to remain in agriculture throughout the project life was afforded the maximum protection possible without measures to eliminate the formation of Soap Lake. These levels of protection varied from 10 percent at the Pajaro River to 1 percent at the edge of Soap Lake.

Although the agricultural damages in this area could not justify affording these degrees of protection, these measures were necessary in order that the upstream improvements would not adversely affect the conditions through this reach.

HYDROLOGIC INVESTIGATION

WATERSHED HYDROLOGY

About 90 percent of the precipitation and all of the historical flooding within the Lower Llagas Watershed have occurred between November 15 and April 15. Average annual precipitation varies roughly with elevation within the watershed and ranges from about 19 inches at the lowest elevations to over 23 inches at the highest. Snowfall is negligible even at the highest elevations. Flooding within the watershed is almost exclusively associated with cyclonic storms. These storms move in from the Pacific and generally exceed 12 hours' duration.

The vegetative cover pattern, like precipitation, varies with elevation. The general pattern is row crop farming on the lowest valley lands, orchard within the main valley area, small grain and pasture on the higher valley lands, range land in the foothills, and dense brush and some timber in the higher hills. Percentage of runoff for equal rainfall amounts is substantially higher from the valley areas than from the hills.

Precipitation data from 7 gages, including 4 recording gages, within or adjacent to the watershed were analyzed. Data sources included the U.S. Weather Bureau, the California Department of Water Resources, and the U.S. Army Corps of Engineers. The data were analyzed by California Department of Water Resource's method and agrees with Weather Bureau findings and the Corps of Engineers Bulletin, "Ten-Year Storm Precipitation in California and Oregon Coastal Basins".

Stream flow records for a 5-year period on Llagas Creek and a 27-year period on nearby Uvas Creek were obtained from U.S. Geological Survey records. One-year records at 4 other points in or near the watershed were obtained from the Department of Water Resources. Because of its longer record, the Uvas Creek gage was used as the key gage from which peak and volume of flows for various frequencies were determined.

HYDROLOGY FOR ECONOMIC STUDIES

Analysis of major historical flooding is the basis for the determination of area inundated versus frequency curves. The three basic points used in developing area inundated versus frequency curves were the areas inundated and the associated frequencies for the floods of 1955 and 1958 and the point at which flooding begins or existing channel capacity as found in a backwater analysis.

Flood data for December 1955 and April 1958 were obtained from field interviews by California Division of Soil Conservation personnel and partially substantiated by photographs taken during the flooding. Supplemental records were obtained from the Red Cross, the California Department of Water Resources, the U.S. Army Corps of Engineers, and the Santa Clara County Flood Control and Water District.

The process for determining area inundated versus frequency curves involved developing a peak discharge versus frequency curve from stream gage and rainfall records; determining the frequency of the 1955 and 1958 floods and the beginning of flooding from the same basic data; combining the above data into a peak flow versus area inundated curve; and plotting area-inundated versus frequency from the previously plotted curves relating both these variables to peak flow.

Data for areas inundated by depth increments were obtained for the 1955 flood by field interview. Total area inundated by floods of different frequencies was found through the use of the previously established area-inundated versus frequency curve.

HYDROLOGY FOR STRUCTURAL DESIGN

Design hydrographs were computed using methods outlined in part 3.21, Section 4, Supplement A of the National Engineering Handbook.

Various factors used in hydrograph computation, such as time of concentration, curve numbers, and storm distribution curves, were developed by using Soil Conservation Service methods of analysis so that indicated peak discharges, volumes, and hydrograph shapes closely approximated data derived from frequency curves and recorded information.

Design hydrographs, based on the 24-hour storm, were routed through the enlarged Chesbro Reservoir proposed in the Upper Llagas Creek work plan report. The reservoir releases were routed downstream and combined with hydrographs of local inflow to form composite hydrographs for the various design reaches on Lower Llagas Creek.

HYDROLOGIC EVALUATION OF LAND TREATMENT MEASURES

The hydrologic effects of land treatment measures were evaluated by computing their effect on composite curve numbers in accordance with procedures in the Hydrology Guide.

Runoff volumes were reduced to show the effect of the curve number change due to land treatment. Peak flows were then proportionately reduced. For economic evaluation these peak flow reductions were translated into area-inundated reductions by the same procedure used in computing the original area-inundated versus frequency curves.

GEOLOGIC INVESTIGATION

SEDIMENTATION

The extent of overbank deposition, although reportedly of considerable magnitude during the floods of 1955 and

1958, is now impossible to evaluate. During the drilling of the test holes for use in channel design, no such recent surficial deposits were noted beyond an occasional deposit of silty sand less than one foot in thickness. Most holes began in dark gray to black, well-developed, plastic clay soils.

Although the downstream reaches of Llagas Creek extending approximately to the Pacheco Pass Highway contain a gravelly bed load, this material, which probably never reaches the Pajaro River, is thought to be derived largely from limited erosion of the adjacent banks. Erosion of these banks is not excessive and the stream is probably in near equilibrium with its bed load. Downstream attrition of the gravels apparently reduces them to sizes capable of being carried as suspended load.

EROSION

Erosion in Llagas Creek is confined to local bank erosion. This may be due to the stream's efforts to maintain a fully satisfied bed load condition. Without bank protection this condition may become more serious in the distant future since the bed load in transit from the upper watershed has now been cut off by Chesbro Reservoir. Again a widespread fire could accelerate bank erosion by aggradation of Llagas Creek channel.

CHANNEL INVESTIGATION

Early in the Llagas Creek investigation a few bank material samples were obtained and primary testing performed for use in preliminary estimates of the cost of channel improvements. After the project had demonstrated an element of feasibility, a program of test hole drilling was conducted during which additional samples were secured and tested.

Holes were drilled adjacent to the existing channel to depths of at least 5 feet below the proposed channel bottom except in those cases where the exploratory holes were stopped short of the required depth by lenses of coarse gravel. A total of 194 feet of hole was drilled at 12 locations along Lower Llagas Creek and

Miller Slough. Representative samples were tested for mechanical analysis and Atterberg limits.

In plastic soils the results of this testing were used in the design of the proposed channels by critical tractive force and limiting velocity criteria. Additional materials' investigations will be made in the final design stage to more precisely evaluate required bottom and bank stabilization measures.

For those reaches in nonplastic soils, channel design was based on grain size. The design velocity was calculated on the assumption that the D75 and larger size gravel would concentrate in and protect the proposed channel bottom.

MATERIALS

Three potential sources of riprap were investigated: 1) a basalt deposit approximately 4 miles northeasterly of Gilroy; 2) a high cliff of silica carbonate rock immediately north of the basalt; and 3) a large existing quarry in Chittenden Pass which produces from a diorite-gabbro body.

It is expected that any of these sources would supply suitable riprap for use as channel lining.

Since there is some question concerning the quantity and blasting quality of the first 2 of the above sources, detailed exploration of these 2 potential quarries will be made. If both of these sources prove unsatisfactory, rock may be hauled from the quarry at Chittenden Pass.

The relatively small amount of concrete aggregate required can easily be obtained from any of the several nearby commercial sand and gravel operations. Filter materials can be obtained from the same source.

ECONOMIC INVESTIGATION

GENERAL

Flood damages were calculated to determine benefits from land treatment and structural measures. Depth, area, seasonal occurrence, location, and frequency of flooding were translated into dollar values for agricultural and urban damages. The damages expected under projected land use were evaluated as if no flood prevention improvements were made.

The Stanford Research Institute's "A Study of Procedure in Estimating Flood Damage to Residential, Commercial, and Industrial Properties in California" was used to evaluate urban damages. These damages were integrated over a 100-year period to determine the average annual dollar damage. The damage reduction attributed to land treatment was then subtracted from the evaluated damages to arrive at the damages subject to reduction by structural measures. In addition to these damage reduction benefits, there are secondary benefits attributed to structural measures. The project benefits and costs were evaluated over a 100-year period using an interest rate of 3-1/8 percent.

LAND USE

The predominant land use of the floodplain under present conditions is agricultural. Fruit, vegetables, seed crops, pasture, and grain are grown in this area of highly productive soils and moderate climate. Principal crops are prunes, apricots, strawberries, sugar beets, beans, garlic, tomatoes and lettuce. The majority of crops in the area are irrigated, mostly from pumped ground water. Under future conditions, much of this highly productive area is expected to remain in agricultural use.

Over three-fourths of the city of Gilroy and about one-half of the unincorporated town of San Martin are within the watershed. According to "A General Plan for South Santa Clara County" published by the County Planning Commission, these 2 urban areas are expected to grow to over 6 times their present population by the year 2000.

The present and projected land uses, as described above, were used in estimating flood damages. Appropriate discounting procedures were used to account for the lag in urban development and phasing out of agriculture on lands taken up by urban uses.

DAMAGE EVALUATION

Types of Damages

Flood damages from inundation and sedimentation were evaluated for agricultural and urban areas under projected development. These damages were evaluated for conditions before and after the installation of land treatment measures. Indirect damages associated with the flooding were included in the total damages to be prevented by the project structural measures.

The separation of floodwater from sediment damages was based on an analysis of factors such as soil structure, flow velocities, cover, and the experience of farmers within the floodplain. This analysis led to associating 85 percent of the total agricultural and urban damages with floodwater and 15 percent with sediment. This breakdown of types of damages is consistent with the findings of the U.S. Department of Agriculture in an overall investigation of the Pajaro River Basin in 1952.

Agricultural Damages

Agricultural damages were evaluated through the use of a composite crop acre which was assumed to remain constant throughout the project life. Change, if any, will be in the direction of higher value development and will result in a conservative statement of benefits.

The composite crop acre was determined as part of the present land use evaluation. This composite acre consisted of barley and vetch hay, strawberries, orchard, garlic, beans, sugar beets, and tomatoes.

Representative crop yields and adjusted long-term prices were determined for each of these crops from the annual reports of the County of Santa Clara Department of Agriculture. Budgets and curves relating net crop income to yield were determined for each crop by use of the above data plus additional information gleaned from interviewing local farmers, the county farm advisor, and others acquainted with local conditions.

Direct crop damages were next evaluated from data collected within the watershed on the effects of the

1955 and 1958 floods. Yields and crop damages were further adjusted according to the month of flood occurrence. The results were checked against data collected for similar conditions in neighboring watersheds by other agencies. The damage value for the composite acre was then determined by weighting the value for each crop according to the amount of that crop within the composite acre.

The final step in evaluating agricultural damage was to convert the composite acre values into average annual values. Present (1965) and future (1985) damages were found for floods of various magnitudes by multiplying the composite acre damage by the number of agricultural acres flooded. By applying an interest rate of 3-1/8 percent and assuming a uniform annual acreage change, these two damage values were combined into a single value for each flood magnitude. A curve showing the relationship of this value with frequency was plotted. Average annual direct agricultural damages were found from the area under this curve. Indirect damages were evaluated as 10 percent of the direct damages. Average annual direct agricultural damages from floodwater were found to be $23,300, and from sediment $4,100, making an annual total of $27,400 (see Table 5).

Urban Damages

The basic hydrologic data used in evaluating urban damages were areas inundated and depths of flooding. Present and future land use within each depth increment was developed in the land use studies. The basic tool used in calculating damages inflicted by flooding on urban development was a series of curves developed by the Stanford Research Institute in 1960 for California flooding. These curves give damage per $1,000 of market value for residential, commercial, and industrial properties as a function of depth of flooding.

Market values used for commercial, industrial, and residential development within the floodplain are based on such sources as field data, a study made by the Berkeley office of the Soil Conservation Service on future urban development in Southern California, and data for other similar watersheds. Values for each urban use were further adjusted to obtain averages applicable over the project life. Final per acre values were $60,000 for residential areas, $170,000 for industrial areas, and $247,000 for commercial areas.

The final step of converting the per acre values into average annual values was accomplished in the same manner used for agricultural damages. However, in this case, indirect damages were assumed to be 15 percent of the direct damages. Total average annual direct urban damages were found to be $370,100.

Unevaluated Damages

Among those damages that were not evaluated in this investigation were the direct damages to roads, railroads, and public facilities; erosion damages, and damages to farm buildings and equipment; the menace of excessive flooding to public health; the detrimental effect of flooding on areal economy; and the disruption of communication and utility services. These direct damages were not evaluated because additional benefits would have an insignificant influence on both project justification and the optimum level of protection.

BENEFIT EVALUATION

Benefits Attributed to Land Treatment Measures

Benefits attributed to land treatment measures were evaluated from associated reduction in flooded area determined during the hydrologic investigation. The reductions in areas were translated into monetary values by assuming damages are directly proportional to flooded area. Using this relationship, benefits of $52,900 annually were attributed to land treatment measures before benefits associated with structural measures were evaluated.

Benefits Attributed to Structural Measures

The total average annual project benefit attributed to the structural measures as shown on Table 6 is $438,800.

This includes $402,400 primary benefits due to flood damage reduction, and $36,400 secondary benefits stemming from and induced by the project.

Two-thirds of the 25 percent reduction in flooded area attributed to the proposed flood detention storage in Chesbro Reservoir is on the Lower Llagas Creek Watershed floodplain. However, all flood damage reduction benefits due to the raising of Chesbro Dam were credited to the Upper Llagas Creek Watershed Project.

Secondary benefits attributed to the structural measures were computed in accordance with Chapter 11 of the Economic Guide. The value of local secondary benefits stemming from the project was considered to be 10 percent of the direct primary benefits. Secondary benefits induced by the project were considered to be 10 percent of the project operation and maintenance costs.

While it is recognized that some residual flooding will occur during extreme floods, the amount when brought to an average annual basis is negligible and therefore benefits attributed to structural measures consist of damages remaining after benefits attributed to land treatment measures have been deducted.

SURVEYS

Field cross sections and detailed maps were obtained for Llagas Creek from its mouth upstream to the proposed Little Llagas diversion near U.S. Highway 101 and for Miller Slough and West Branch Llagas Creek. These sections, following existing channel alignment, were taken wherever significant changes in channel configuration occurred.

Horizontal control was established by a tape transit traverse and vertical control by rod and level using U.S. Geological Survey 1927 North American mean sea level datum. Topographical data for channels which do not follow existing creeks were obtained from field profiles using rod and stadia control and checked for general conformation with U.S. Geological Survey quadrangle maps of the area.

All existing bridges were measured in order to determine their present capacities and their influence on channel design and quantities. All utilities, crossing or immediately alongside proposed structural measures, were located and inspected in the field to determine whether relocation or modification is required.

HYDRAULIC DESIGN

During periods of flooding Llagas Creek flows into and is partially controlled by Soap Lake. This lake forms on the average of about once in 10 years when the capacity of the Pajaro River is exceeded. A stage-frequency relationship for Soap Lake was derived by computing a series of backwater curves starting at the Chittenden gage on the Pajaro River. This relationship was used to establish design capacities of Llagas Creek through the Soap Lake reach. These channel capacities, which are the maximum attainable without measures on the Pajaro River to prevent the formation of Soap Lake, vary from the 10-percent flow at the Pajaro River to the full 1-percent capacity at the fringes of the 1-percent Soap Lake stage.

Backwater curves on the Pajaro River were computed by the Standard Step Method. Manning's roughness coefficients for the channel were estimated from field inspection and photographs.

Channel design in areas having plastic soils is based on the tractive force theory. The design relationship used for relating allowable tractive force and plasticity index was developed by the U.S. Bureau of Reclamation and proved applicable to the Santa Clara Valley by evaluating those forces existing channels have successfully withstood.

As an additional safety precaution, provision is made for seeding all unlined channels. A Manning's "n" of 0.030 was used in hydraulic design to allow for vegetation as well as such minor losses as occur at curves and bridge piers. Design velocities are sufficiently high to maintain enough sediment movement to prevent excessive deposition.

Channel design in areas with nonplastic soils is based on the limiting tractive force values obtained from Technical Release 25 of the Soil Conservation Service. The limiting tractive force values obtained proved too restrictive to permit the economical use of unlined earth channels.

Since geologic investigation indicated that the material in the streambanks is generally poorer than in the bed, channels in nonplastic soils were designed with riprapped sides and natural bottoms.

The tractive force on the bottom is evaluated by use of methods adopted from Einstein's sediment transport theory and limited to the values given in Technical Release 25 for material of the size of the predicted armor coat. The theoretical functioning of the design is for the fines to gradually wash downstream, leaving on the bottom an armor coat composed of the coarsest quarter of the existing bedload material. A Manning's "n" of 0.035 was used in hydraulic design and reflects the additional coarseness of bank and bed materials over that found in cohesive soils.

All channels are provided with freeboard in accordance with the Soil Conservation Service's Far West States Engineering Design Standards. In no case does the design slope reach 0.7 of critical.

Grade stabilization structures are used in this work plan where they are needed to keep design tractive forces within the allowable limits. Extensive use was made of available literature and recommended Soil Conservation Service criteria in designs for the purpose of cost evaluation.

STRUCTURAL DESIGN

A basic concept used in channel improvement work is to keep the design water surface at or slightly below the existing ground elevation in order to allow local inflow of storm runoff. Therefore, levees are generally required only to provide freeboard except in reaches across depressions in the existing profile or where backwater conditions do not permit such a design.

Side slopes of 2 to 1 are used throughout the project and should present no stability problems. Channel side slope areas not covered with riprap will be seeded and watered until the vegetation is established. A maximum bottom width to depth ratio of 10 to 1 was used throughout the project except in the transition reach through Soap Lake.

Riprap protection is provided on both banks for all channels located in noncohesive soils, upstream and downstream from all grade stabilization structures, around drainage inlets, and on each leg of all channel junctions. All curves having a radius under 800 feet are provided with riprap protection for earth channels, and an increased riprap thickness for curves through areas of noncohesive soils.

The riprap extends from 1 foot above design water surface to 3 feet below the proposed channel bottom to provide insurance against undermining. Soil Conservation Service criteria were followed in establishing riprap thickness and rock size. Six inches of filter material is provided under all riprap.

Drainage inlets are provided to allow local drainage and storm runoff to enter the proposed channels at regular intervals.

Grade stabilization structures were checked generally to make sure that the provided quantities are sufficient to insure a structurally safe design. Pertinent data are given on Table 3.

Existing bridges over the improved channels were considered hydraulically adequate if they would pass the design flood with 1 foot of clearance and structurally adequate if the designed channel would not so expose the substructure as to endanger the stability of the bridge. Estimates for new bridges allow a length equal to the design water surface width.

Maintenance roadways are provided on both sides of all proposed channels.

COST ESTIMATION

LAND TREATMENT MEASURES

The land treatment needs were developed for the watershed by major land uses. The amounts of each practice to be installed were multiplied by the appropriate unit cost to arrive at a total cost of $105,800 for the installation of land treatment measures.

The unit costs for installation of on-farm land treatment measures were based on current costs of materials and construction. For those practices involving farm labor and equipment, costs were derived from recent studies made by the Soil Conservation Service in the area.

The cost for planning the land treatment was computed to be $15,100 using man-hour factors per measure, distribution of man-hours per technician, and hourly rates. The estimate of $9,100 for technical assistance furnished by the going program during project installation was obtained from an analysis of work unit records, and the past accomplishments of the Loma Prieta Soil Conservation District. The residual cost of $6,000 will be supplied from Public Law 566 funds.

STRUCTURAL MEASURES

Construction Costs

Construction costs are based on quantities calculated for the proposed structural measures and estimated average unit costs of the individual items. Unit costs are based on actual bid prices for similar works under comparable conditions in the northern part of Santa Clara County and upon analysis of other applicable cost data which were furnished by various agencies. For drainage inlets, unit costs were estimated from tentative designs on a per each basis. Estimates are based on average requirements of eight inlets per mile without designating specific locations. All estimated contract costs, based on quantities, were increased 15 percent for contingencies.

Installation Services

Total installation services cost was estimated as 22.5 percent of the construction cost plus additional sums of $15,000 for hydraulic model studies for drop structures, and $20,000 for geologic exploration of a suitable source of riprap. The percentage value includes engineering, and Federal administrative functions at the state and national level. Engineering consists of performing final construction surveys, final design of structural measures, preparation of plans and specifications, and supervision of construction.

Rights-of-Way Costs

Rights-of-way costs were estimated by the Santa Clara County Flood Control and Water District. They are based on field inspection by their personnel and sales recently completed in the immediate vicinity. Land values within the required right-of-way range between $2,000 and $7,000 per acre depending on location and present land use. Areas within the present channel were assigned the nominal value of $100 per acre.

All costs are based on fee title acquisition of the required property even though actual construction may be completed on the basis of easements in some instances. Costs associated with acquiring the land for rights-of-way were computed on a per parcel basis. The estimated cost of $1,000 per parcel for right-of-way engineering, survey, appraisal, escrow, and legal fees used is based on cost experienced by the Santa Clara County Flood Control and Water District in acquiring land for other projects.

Utility Modification Costs

Unit costs for new bridges were furnished by the California Division of Highways and are in line with cost experienced by Santa Clara County.

Eight dollars per square foot was used for private wooden bridges and $15.00 per square foot for county and state bridges.

Other utility modification costs (various pipe lines, telephone cables, power poles, wells, etc.) were obtained from the utility company or other owner involved, and checked against the experience of the Santa Clara County Flood Control and Water District in relocating similar type utilities elsewhere in the county.

Administration of Contracts

An allowance of 1 percent of the total construction cost was included for the local administration of contracts.

Operation and Maintenance

The estimated average annual cost for the operation and maintenance of structural measures is $19,200. This was estimated on a cost per mile basis from data furnished by the Santa Clara County Flood Control and Water District. It includes the cost of labor, equipment and materials for maintaining the channel, and the cost of administration.

The annual cost given above is adjusted to long-term projected price levels.

WORK PLAN

PROJECT MAP

LOWER LLAGAS CREEK WATERSHED PROJECT

LOMA PRIETA SOIL CONSERVATION DISTRICT
SANTA CLARA COUNTY, CALIFORNIA

PRELIMINARY PLANS

THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF CONSERVATION, DIVISION OF SOIL CONSERVATION
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by S.D.S.C. Date JUNE 1965 Dwg. No. ______